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INFRARED REPEATER SYSTEM, METHOD, AND ADJUSTABLE BRIGHTNESS EMITTER THEREFOR

FIELD OF THE INVENTION

The present invention relates to remote control systems for consumer electronic devices and, more specifically, to an adjustable brightness infrared (IR) emitter and method for use in connection with an IR repeater system. It is to be understood that the description of the invention herein is intended to be exemplary and explanatory only.

BACKGROUND OF THE INVENTION

Many consumer electronic devices may be controlled remotely via a wireless remote control unit. Such devices include, for example, television receivers, cable or satellite receiver boxes, video cassette recorders, digital video disc (DVD) players, audio equipment such as amplifiers, receivers, compact disc players, magnetic tape players, and the like.

Such devices may be operated remotely using handheld remote control units. Commonly, such remote control units transmit IR light signals representing coded electrical signals modulated on a carrier frequency in the range of about 36-40 kHz. The transmitted IR light signal is received by an IR receiver in the consumer electronic equipment, demodulated, decoded, and the appropriate action taken.

IR remote control units are line-of-sight devices. IR repeaters have been developed to allow users to exercise remote control of devices which are out of sight of the user, e.g., when the electronic equipment is hidden in a cabinet, remotely located from the user, e.g., in different rooms in a home, or otherwise located beyond the operational range of the hand held remote control unit.

An IR repeater includes an IR sensor or detector for detecting coded IR light signals produced by the remote control unit and producing an electrical signal representative of the incoming IR signal. Commonly, an IR receiver is electrically coupled to an IR transmitter and the electrical signal is passed thereto. The IR transmitter generates an IR light signal which reproduces the original IR light signal received by the IR receiver. The consumer electronic equipment receives this IR light signal from the IR transmitter and performs the selected function. The IR detector is located where it can receive the IR light signals from the remote control unit. The IR transmitter includes an IR light emitter which is placed such that emitted light will impinge upon the IR detector of the device to be controlled, and is typically mounted directly adjacent thereto.

However, it has been discovered that the IR receivers of many consumer electronic devices are too sensitive for mounting existing IR emitters in adjacent relation thereto. Accordingly, the present invention provides a new and improved IR repeater system, emitter, and method that overcome the above-referenced problems and others.

SUMMARY OF THE INVENTION

In a first aspect, an IR emitter of a type for use with an IR repeater system comprises an IR light source and a manually adjustable brightness control.

In another aspect, an IR repeater system includes an IR detector for detecting an IR light signal and generating an electrical signal in response thereto and a transmitter coupled to the IR detector for generating an output IR signal. An IR emitter electrically coupled to the transmitter for emitting an IR light signal includes an IR light source and a manually adjustable brightness control.

In a further aspect, a method for effecting control of an electronic device comprises operating a remote control device to generate a first IR control signal and receiving the first IR control signal at an IR detector located remotely from the electronic device. A second IR control signal, which substantially replicates the first IR control signal, is produced in response to the first IR control signal to drive an IR emitter having a manually adjustable brightness control. It is determined whether IR emitter has an appropriate brightness level for the IR receiver of the electronic device, e.g., via the detection of transmission errors, if the IR emitter does not have an appropriate brightness level for the IR receiver of the electronic device, the brightness level of the IR emitter is manually adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and together with the description of the invention herein, serve to explain the principles of the invention.

FIGURES 1 and 2 are functional block diagrams illustrating a exemplary remote control systems including the IR emitter with adjustable brightness according to the present invention.

FIGURE 3 illustrates an adjustable brightness IR emitter according to a first embodiment of the present invention.

FIGURE 4 illustrates an adjustable brightness IR emitter according to a second embodiment of the present invention.

FIGURE 5 illustrates an adjustable brightness IR emitter according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGURE 1 illustrates an IR repeater system **10** according to an exemplary embodiment of the present invention. The system **10** may be operated with a remote control unit **12**, such as a hand-held remote control unit, and includes an IR repeater or extender unit **14**. The unit **14** includes an optical receiver **16** and an optical transmitter **18**, and operates using a power supply **20**, which may be for example a battery, or a DC power source, e.g., connected to an electric power mains.

The optical receiver **16** includes at least one detector **22**, such as a photodiode, phototransistor, or the like. The optical receiver **16** receives an incoming IR optical signal **26** and converts it to an electrical signal representative of the incoming signal **26**. The electrical signal is passed to an optical transmitter **18** which drives one or more, up to *N*, IR emitters **30**, wherein *N* is an integer, via a transmission line **31** to produce an optical signal which

substantially replicates the original signal. As used herein, the term "substantial" is intended to encompasses minor variations between the original signal and the repeated signal as would not affect the ability to control a device to be controlled **42**, including slight mistuning due to small differences in the carrier frequency and other differences.

The IR emitter **30** includes an IR light emitting device such as an IR light emitting diode (LED) or other IR light source **32**, preferably in a housing or enclosure which is positioned in proximity to an IR receiver **40** of a device **42** to be controlled. Preferably, the LED or other IR source **32** is mounted or secured directly over the receiver **40**, e.g., via an fastener, such as a clip, adhesive, or other fastener.

The emitter **30** further includes a variable resistor **34** electrically connected to the source **32** for adjusting the brightness of the source **32** to a level appropriate for the receiver **40** of the particular device **42** being controlled. In operation, an inappropriate brightness level can be determined by transmission errors, e.g., identified when the controlled equipment fails to properly respond in response to a transmitted control signal. In this manner, errors resulting from an inappropriate brightness level can be avoided and transmission errors minimized or eliminated. For example, in the case of oversaturation of the receiver **40**, the variable resistor **34** can be manually adjusted to reduce the current level supplied to the IR source during emission.

Referring now to FIGURE 2, there is shown an IR repeater system **110** according to a further exemplary embodiment of the present invention. The system **110** may be operated with a remote control unit **12** and operates using a power supply **20**.

At least one, and up to *M*, IR targets **116**, where M is any integer, are electrically coupled to a base unit **118** via lines **24**, thereby allowing the targets **116** to be placed at one more desired locations remote from the base unit **118**, which may be placed at a central location. However, one or more IR sensors integral with the base unit **118** are also contemplated.

The IR targets **116** include an IR photosensor, such as photodiode, phototransistor, or the like. The targets **116** receive an incoming IR optical signal **26** and convert it to an electrical signal representative of the incoming signal **26**. The electrical signal is passed to the base unit **118** which drives one or more IR emitters **30** comprising an IR source **32**, such as an IR LED, and a potentiometer **34** electrically coupled to the base unit **118** via a transmission line **31**.

The IR light source **32** is preferably mounted in a housing or enclosure which is adapted to be positioned in proximity to an IR receiver **40** or a device **42** to be controlled. Preferably, the emitter **32** is mounted, e.g., via an adhesive or mechanical fastener, directly over the receiver **40** portion of the device **42**. The emitter **30** further includes a variable resistor **34** electrically coupled to the source **32** for adjusting the brightness of the emitter **32** to a level appropriate for the receiver **40** of the particular device **42** being controlled, thereby avoiding transmission errors due to oversaturation of the receiver **40**.

Referring now to FIGURES 1 and 2, it will be recognized that the optical signal may be received and transmitted by a number of methods. For example, in some instances, the current produced by the photosensor may simply be amplified and supplied to the IR emitter such that the

modulated signal is retransmitted directly. Alternatively, the IR receiver may include a demodulator which produces a demodulated signal which can be used to switch an oscillator on and off, the oscillator having a frequency at or near that of the carrier frequency of the remote control unit **12**. The output of the oscillator can then be passed to the IR transmitter circuitry to drive the emitters **32**.

FIGURE 3 illustrates an exemplary IR emitter **30** in accordance with a first embodiment of the present invention comprising an IR source **44**, such as an IR LED, mounted in a housing **32**. The source **44** is electrically connected to transmission circuitry (see, e.g., FIGURES 1 and 2) via a transmission line **31**, which may be a two-conductor wire. The line **31** terminates in a plug-in connector **36**, such as a standard monaural phone plug, preferably a one-eighth-inch phone plug, which may be received in a complimentary jack electrically connected to the optical transmission or driving circuitry of an IR repeater. The connector **36** is preferably of a standard connector type, such as RCA- or phono-type connectors, or any other size or type of electrical connector.

The connector **36** includes a housing **38** enclosing a potentiometer **34** electrically connected to the emitter **44**, e.g., in series circuit arrangement therewith, for controlling the level of the current flowing thereto. In the depicted embodiment the potentiometer **34** includes a rotatable shaft **35** which can be rotated to control the amount of current which flows to the LED **44**, although sliding and other types of variable resistors are contemplated as well. Preferably, the shaft **35** is flush with the housing **38** so as to prevent inadvertent rotation of the shaft **35**, e.g., during handling, and preferably includes a slot **33** or other recess or surface

feature allowing rotational adjustment with a complimentary tool.

With reference now to FIGURE 4, there appears an alternative exemplary IR emitter **30** in accordance with a second embodiment of the present invention comprising an LED or other IR source **44** mounted in a housing **32** adapted to be mounted on a device **42** to be controlled. The emitter **44** is electrically connected to transmission circuitry via a transmission line **31** which, in the depicted embodiment, terminates in a plug-in connector **36**, as described above by way of reference to FIGURE 3. However, it will be recognized that a plug-type electrical connector (36, 38) may be omitted in the FIGURE 4 embodiment and that the emitter **30** may alternatively be provided with wire leads which may be electrically coupled to the transmitter via any method for connecting cables without using plugs, including screw terminals, barrier strips, spring-loaded terminals for accepting bare wire leads, or other connector, and which may be, for example, an end user-supplied connector.

A potentiometer **34** is enclosed in the emitter housing **32** and connected in series with the emitter **44**. Again, the potentiometer **34** includes a rotatable shaft **35** for controlling the amount of current which flows to the LED **44**, although sliding and other types of variable resistors are also contemplated. Preferably, the shaft **35** is flush with the housing **32** so as to prevent inadvertent rotation of the shaft **35** and preferably includes a slot **33** for rotational adjustment.

With reference now to FIGURE 5, there appears an further alternative exemplary IR emitter **30** in accordance with a third embodiment of the present invention comprising an LED

or other IR emitter **44** mounted in a housing **32**. The emitter **44** is electrically connected to transmission circuitry via a transmission line **31** which terminates in a plug-in connector **36** as described above.

A potentiometer **34** is enclosed within a housing **38** along the transmission line **31** and is connected in series with the emitter **44**. The potentiometer **34** includes a rotatable shaft **35** for controlling the amount of current which flows to the LED **44**, although sliding and other types of variable resistors are also contemplated. Preferably, the shaft **35** is flush with the housing **32** to prevent inadvertent rotation of the shaft **35** and preferably includes a slot **33** as described above. Again, the depicted plug-type electrical connector (36, 38) may be omitted in the FIGURE 5 embodiment and the emitter **30** may alternatively be provided with wire leads which may be electrically coupled to the transmitter via any method for connecting cables or bare wire leads without using plugs, such as described above by way of reference to FIGURE 4.

The invention has been described with reference to the preferred embodiment. Modifications and alterations will occur to others upon a reading and understanding of the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations.